Exhibit J

U.S. DEPARTMENT OF AGRICULTURE
WASHINGTON, D.C. 20250

DEPARTMENTAL REGULATION

NUMBER:
1020-6

SUBJECT:
Policies on American Indians and Alaska Natives

DATE: October 16, 1992

OPI: Office of Public Affairs
Office of Intergovernmental Affairs

1 PURPOSE

The purpose of this document is to outline the policies of the United States Department of Agriculture (USDA) in its interactions with Indians, Alaska Natives, tribal governments, and Alaska Native Corporations (ANC). USDA policies are based on and are coextensive with Federal treaties and law. These policies pertain to Federally recognized Tribes and ANCS, as appropriate, and provide guidance to USDA personnel for actions affecting Indians and Alaska Natives. These policies do not involve USDA interactions with State-recognized Tribes, Indians, or Alaska Natives who are not members of Tribes with respect to matters provided for by statute or regulation.

2 DEFINITIONS

a Indian tribe (or tribe). Any Indian tribe, band, nation, Pueblo, or other organized group or community which is recognized as eligible for the special programs and services provided by the United States to Indians because of their status as Indians.

b Alaska Native Corporation. Any Alaska Native village or regional corporation established pursuant to the Alaska Native Claims Settlement Act, Pub. L. No. 92-203 (ANCSA).

c Indian. A member of an Indian tribe.

d Alaska Native. As defined by section *3(b) of ANC*SA, a citizen of the United States who is a person of one-fourth degree or more Alaska Indian (including Tsimshian Indians not enrolled in the *Metlakla Indian Community) Eskimo, or Aleut blood, or a combination thereof. The term includes any Native as so defined either or both of whose adoptive parents are not Natives. It also includes, in the absence of proof of a minimum of blood quantum, any citizen of the United States who is regarded as an, Alaska Native by the Native village or Native group of which he/she claims to be a member of whose father or mother is (or, if deceased, was) regarded as Native by any village or group.

e Tribal government. The governing body of an Indian tribe that has been officially recognized as such by the Federal Government.

3 BACKGROUND

The United States Government has a unique, legal and political relationship with Indians and their tribal governments as defined through treaties, statutes, court decisions, and the United States Constitution. The United States Government has obligations under treaties and statutes to protect and maintain the lands, resources, and traditional use areas of Indians. Tribal governments have powers similar to those of State governments. In Alaska, the relationship with ANCs is defined by ANCSA, as amended.

4 POLICIES

a. USDA is the lead agency of the Federal Government for providing effective and efficient coordination of Federal agricultural and rural development programs. USDA recognizes that Indians possess the right to govern themselves and manage their resources. Therefore, USDA supports and seeks to further the principles of self-governance as delineated in the Indian Self-Determination and Education Assistance Act of 1975.

b. Consistent with applicable law, USDA officials will consult with tribal governments and ANCs regarding the influence of USDA activities on water, land, forest, air, and other natural resources of tribal governments and ANCS.

c. USDA recognizes that tribal governments and ANCs manage land for such agricultural activities as farming, grazing, hunting, fishing, subsistence agriculture, and gathering of plants, animals, and plant products. USDA further recognizes that such resources may hold a unique meaning in the spiritual as well as everyday lifeways of many Indians and Alaska Natives. Consistent with applicable law, USDA officials will solicit input from tribal governments and ANCs on USDA policies and issues affecting tribes and will seek to reconcile Indian and Alaska Native needs with the principles of good resource management and multiple use.

d. USDA agencies will observe the American Indian Religious Freedom Act, Pub. L. No. 95-341.

e. USDA officials will work with the tribal governments, tribal high schools, colleges and universities to encourage the development of agribusiness skills, awareness and, where needed, curricula. USDA will share information through the exchange of technical staffs and skills.

f USDA officials will work with other Federal and state agencies with responsibilities to tribal governments and ANCs and will encourage early communication and cooperation among all such organizations.

g Consistent with applicable law or regulation, USDA managers will facilitate tribal and ANC participation in USDA program planning and activities.

5 RESPONSIBILITY

The Secretary of Agriculture is responsible for insuring that this policy is followed. The Secretary has delegated authority to certain USDA agencies for carrying out these policies. The Office of Public Affairs, Native American Programs Office, has primary responsibility for coordinating USDA agencies' programs serving Indians and Alaska Natives. The Office of Advocacy and Enterprise has primary responsibility for coordinating USDA's equal employment, civil rights, and employment-related outreach to Indians and Alaska Natives.

6 INQUIRIES

Questions or comments pertaining to this regulation may be directed to the Office of Public Affairs, Native American Programs Office, Room 112-A, Washington, D.C., 20250-1300. Telephone 202-720-3805.

Further information on USDA programs will be available in the "Guide to USDA Programs for Native Americans."

- end -

Exhibit K

VICTOR M. SHER
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HONORABLE CAROLYN R. DIMMICK

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IN THE UNITED STATES DISTRICT COURT
FOR THE WESTERN DISTRICT OF WASHINGTON

DIOXIN/ORGANOCHLORINE CENTER, and COLUMBIA RIVER UNITED, Plaintiffs, v. DANA A. RASMUSSEN, et al., Defendants.	)	Civ. No. C93-0033D DECLARATION OF DONALD C. MALINS IN SUPPORT OF CRU'S MOTION FOR SUMMARY JUDGMENT

I, DONALD C. MALINS, declare as follows:

1. My name is Donald C. Malins. I hold Doctor of Philosophy and Doctor of Science degrees in biochemistry. I am currently Head of the Molecular Epidemiology Program at the Pacific Northwest Research Foundation, an independent, non-profit medical research facility, located in Seattle, Washington. I am an expert in the field of biochemistry and toxicology, particularly in relation to the effects of environmental chemicals on aquatic organisms and the etiology of cancer.

2. Other posts which I presently hold are an affiliate professorship in the University of Washington's Department of Environmental Health and a Research Professorship in Chemistry at Seattle University. I am one of the founders of,

and have been for many years the Editor-in-Chief of, the international journal *Aquatic Toxicology*. I have also served as a U.S. member of the Science Advisory Board of the International Joint Commission for the Great Lakes. A copy of my Curriculum Vitae is attached hereto as Exhibit A and is incorporated herein by reference.

3. Since 1967, my principal professional work has involved field and laboratory studies of the effects of environmental chemicals on aquatic organisms. In the last four years I have also been concerned with the role played by environmental chemicals in human cancer. I have specialized knowledge in the toxicology of chlorinated hydrocarbons, including the chemicals known as polychlorinated dibenzo-p-dioxins ("PCDDS" or "dioxins").

4. I have reviewed portions of the Record relating to the Environmental Protection Agency's (EPA's) promulgation of a dioxin limit for the Columbia River, including the following documents: <u>Total Maximum Daily Loading (TMDL) to Limit Discharges of 2,3,7,8-TCDD (Dioxin) to the Columbia River Basin</u> (the "TMDL") issued by USEPA on 25 February, 1991, AR 19, [1] and EPA's <u>Responses to Comments</u> thereto; <u>Interim Procedures for Estimating Risks Associated with Exposures to Mixtures of Chlorinated Dibenzo-p-Dioxins and -Dibenzofurans (CDDs and CDFs)</u>, AR 51(1) [16]; <u>Integrated Risk Assessment for Dioxins and Furans from Chlorine Bleaching Pulp and Paper Mills</u>, AR 143 [15]; Letter from Victor M. Sher to EPA dated July 20, 1990, AR 94; Letter from Mary O'Brien to EPA, June 25, 1990, AR 56; <u>Analysis of the</u>

Potential Populations at Risk from the Consumption of Freshwater Fish Caught Near Paper Mills, AR 121 . Where I have drawn upon my knowledge outside of the Record to formulate this declaration, I have so noted and referenced in the text. In each case I have relied on published materials readily available and which any reasonable investigation should have uncovered.

5. Having reviewed EPA's proposed TMDL and the accompanying documents, I offer this declaration for two purposes: 1) to explain to the Court why EPA could not rely solely on human cancer risk as a criterion for protection of aquatic life and wildlife, and how EPA's failure to address non-human, non-cancer risks posed to aquatic organisms and wildlife would affect the analysis underlying EPA's decision on its TMDL, and 2) to explain to the Court the relevance of EPA's failure to consider analyses provided by its own scientists with respect to human health effects.

6. EPA failed altogether to make two analyses crucial to a determination of whether its TMDL would protect aquatically-dependent species. First, EPA failed to address how wildlife and other aquatically-dependent species would be protected by a criterion based on human cancer risk. Second, EPA's failure to analyze the toxic background exposure of target species would necessarily result in an underestimation of the toxic effects of exposure to 2,3,7,8-TCDD in their environment. EPA's failure even to address these issues is especially distressing given that questions about them were repeatedly raised in the record. If EPA had properly considered the concerns raised at AR 56 and AR

94, for instance, it is my opinion that EPA could and likely would have reached a different result with respect to the level of dioxin permitted to be discharged under the terms of the TMDL.

7. The potency of 2,3,7,8-TCDD as an environmental toxin is well described [16]. Its dangers have largely been expressed in terms of its propensities to produce cancer as an endpoint of exposure. Although dioxin clearly is a carcinogen in the classic sense, dioxin also induces changes on much simpler levels than required for cell proliferation and lesion or tumor production, such as changes in the activity of the cytochrome p450 enzyme system, which goes up in response to 2,3,7,8-TCDD. Thus a number of other endpoints, including reproductive impairment [2, 3], cytogenetic changes [4, 5], immune system dysfunction [6] wasting syndrome [7], and alterations in sexual behavior and development, have been observed in animals other than man. In fact, many aquatically dependent species do not develop cancer at all as a response to classic carcinogens known to produce cancer in mammalian species [12, 14]. Thus, the evidence would in fact suggest that cancer is not only inappropriate for assessing environmental health, but may be relatively insensitive when compared to other endpoints at the exposure levels seen in the environment [5, 13].

8. Further, the human cancer risk criterion is inapplicable to aquatic species because the model guiding the criterion does not take into account factors such as special sensitivities of the many diverse forms of aquatic life, including the fact that many of these life forms exhibit

heightened sensitivities at different developmental or life stages [14]. In this context, the chicken embryo is negatively affected by dioxin down to the lowest concentrations of dioxin observable [15]. Considering that some species, such as birds, exhibit growth abnormalities on dioxin exposure at extremely low doses in the embryonic phase [15], EPA could not simply assume that its cancer model would provide adequate protection at non-cancer endpoints for non-human species without further analysis.

9. Second, EPA's rationale for ignoring other toxic chemicals in its analysis completely misstates the problem of cumulative toxic effects [1]. 2,3,7,8-TCDD is not the only chlorinated organic which induces biological effects via so-called "receptor-mediated" mechanisms. A host of environmental contaminants are known to operate mechanistically, and affect the same transformations at the same receptor, as 2,3,7,8-TCDD. AR 56. DDT, polychlorinated dibenzofurans (PCDFs), and PCB's are but a few of the more common toxic substances believed to incorporate this mechanism. Many of these substances, in addition to chlorinated guaiacols, resin acids, and a host of other potentially toxic substances, are also present in pulp mill waste. It has been documented that these compounds act interdependently in many cases [8]. In particular, health effects of dioxins, furans, and PCBs which occur in complex mixture are correlated with the total equivalency exposure, as would be predicted from a linear model with partial occupancy of the receptor. Thus, even if EPA is reluctant to regulate these compounds as a group [19], it still cannot ignore these chemicals

for the purpose of determining the health effects of the single chemical, 2,3,7,8-TCDD, on the organisms in the Columbia River, because by doing so, EPA will understate the risks posed to these species. Depending on the slope of the dose-response curve, an organism may be at much, much greater risk than that predicted by the presence of dioxin alone.

10. Even without considering the toxic equivalencies of dioxin and other chlorinated compounds, it is clear that the presence of these substances in the discharge environment places exposed organisms at heightened environmental stress. My own studies and those of others have shown that organisms exposed to toxic chemicals are predisposed to serious biological effects in relation to the amount of toxic chemical exposure [12, 17]. A chemically stressed system provides less margin for error because the organisms are handicapped by toxic loads that reduce the resiliency of response and recovery of these organisms to additional toxic insult or other environmental stress. Without factoring existing contamination in, there is no way to assess with any scientific credibility what potential harm is posed by the addition of this additional toxic stress.

11. The lower Columbia River presents a particularly poignant example of the kind of toxic milieu that real-world organisms are up against. Apart from the elevated levels of dioxin documented from fish [1], accumulations of PCBs and DDE, furans, other organochlorines, and mercury have been found in a range of higher trophic level species living in the Columbia River basin, including harbor seals, mink, river otters and bald

eagles [10, 11]. In the case of mink and bald eagles, the levels of PCBs and DDE are within ranges known to impair reproduction [10, 11]. It is not appropriate to address the question of whether dioxin standing alone constitutes a potential health threat to these organisms in the context of their existing toxic environment, any more than it would be appropriate for EPA to treat each discharge source on the river as the sole source of dioxin entering the stream. If anything, the accumulations of these and other toxic substances may well lead a rational decisionmaker to the conclusion that there is no margin of safety that would permit the discharge of <u>any</u> additional substances with the potential to impair reproduction.

12. Finally, I must agree with the analysis provided by EPA's own scientists regarding the enhanced risk of human cancer for persons consuming greater than average amounts of fish. AR 121. However, even this analysis understates the risks to human consumers of fish. As with aquatic organisms and wildlife, sensitivities to contaminant exposure varies widely, particularly at sensitive life stages. Thus, exposure to given dioxin levels may place some human age groups, such as children, particularly at risk. EPA cannot provide a scientifically defensible margin of safety for these particularly sensitive subpopulations without explicitly including assumptions about the nature of these differential risks in the analysis of EPA's TMDL.

CONCLUSION

13. The relevance of EPA's failure to undertake certain fundamental analyses is, in my opinion, that it renders

the TMDL meaningless with respect to its protection of aquatic organisms and wildlife. If EPA made assumptions regarding the safety of its regulation for these organisms, it certainly is not supported by any of the discussions in the record. Critically, aquatic organisms and wildlife are likely to be affected in ways that may cause them harm at much lower concentrations of dioxin exposure than predicted by a human cancer risk model. Among the most important considerations not addressed by EPA's failure to take into account aquatic organisms and wildlife is that contemporaneous exposure to organochlorines and PCB's greatly enhances the risk posed to these organisms in the toxic environment. Indeed, in my view, in the absence of further analysis and considering the presence and extent of these other chemicals in the Columbia River, it seems unlikely that EPA can justify any level of dioxin discharge that is "safe" for the Columbia River's aquatic organisms and wildlife. Finally, I concur with the evidence from the record that indicates heightened susceptibility of cancer risk to human subpopulations that are exposed to dioxin in ways that EPA has not considered.

I declare under penalty of perjury that the foregoing is true and correct to the best of my knowledge. Executed this 31st day of March, 1993, in Seattle, Washington.

Donald C Malins

DONALD C. MALINS

MAL402.DEC

1. U.S. ENVIRONMENTAL PROTECTION AGENCY (USEPA). 1991. Total Maximum Daily Loading (TMDL) to Limit Discharges of 2,3,7,8-TCDD (Dioxin) to the Columbia River Basin. USEPA, Seattle, Washington.

2. SILBERGELD, E.K., et al. 1987. Experimental and Clinical Studies on the Reproductive Toxicology of 2,3,7,8-Tetrachlorodibenzo-p-dioxin. American Journal of Industrial Medicine; 11(2): 131-144.

3. UMBREIT, T.H., et al. 1987. Reproductive Toxicity in Female Mice of Dioxin-contaminated Soils from a 2,4,5-Trichlorophenoxyacetic Acid Manufacturing Site. Archives of Environmental Contamination and Toxicology; 16(4): 461-466.

4. GIRI, A.K. 1986. Mutagenic and Genotoxic Effects of 2,3,7,8-tetrachlorodibenzo-p-dioxin, a Review. Mutation Research; 168(3): 241-248.

5. LILIENFELD, D.E., et al. 1989. 2,4-D, 2,4,5-T, and 2,3,7,8-TCDD: an Overview. Epidemiological Review; 11:28-58.

6. CHASTAIN, J.E., et al. 1985. 2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD)-induced immunotoxicity. International Journal of Immunopharmacology; 7(6): 849-856.

7. POHJANVIRTA, R., et al. 1988. Screening of Pharmacological Agents Given Peripherally with Respect to TCDD-induced Wasting Syndrome in Long-Evans Rats. Pharmacological Toxicology; 63(4): 240-247.

8. SVENSSON, B.-G., et al. 1991. Exposure to dioxins and dibenzofurans through the consumption of fish. The New England Journal of Medicine; 324: 8-12.

9. BANNISTER, R., and S. SAFE. 1987. Synergistic interactions of 2,3,7,8-TCDD and 2,2',4,4',5,5'-Hexachlorobiphenyl in C57BL/6J and DBA/2J Mice: Role of the Ah Receptor. Toxicology; 44: 159-169.

10. GARRETT, M., R.G. ANTHONY, J.W. WATSON, and K. McGARIGAL. 1988. Ecology of Bald Eagles on the Lower Columbia River. Unpublished report to U.S. Army Corps of Engineers. 189 pp.

11. U.S. FISH AND WILDLIFE SERVICE. 1990. Briefing on the Columbia River. Memorandum from Russell Peterson, Field Supervisor, U.S. Fish and Wildlife Service, Jan. 11, 1990. 6 pp.

12. MALINS, D.C., et al. 1988. Neoplastic and Other Diseases in Fish in Relation to Toxic Chemicals: an Overview. Aquatic Toxicology; 11: 43-67.

13. ROBERTS, L. 1991. Dioxin Risks Revisited. Science; 251:624-626.

14. MALINS, D.C., AND G.K. OSTRANDER. 1991. Perspectives in Aquatic Toxicology. Annual Review of Pharmacology and Toxicology; 31: 371-399.

15. U.S. ENVIRONMENTAL PROTECTION AGENCY. 1990. Integrated Risk Assessment for Dioxins and Furans from Chlorine Bleaching in Pulp and Paper Mills. EPA 560/5-90-011, Pp. 16-17.

16. U.S. ENVIRONMENTAL PROTECTION AGENCY. 1989. Interim Procedures for Estimating Risks Associated with Exposures to Mixtures of Chlorinated Dibenzo-p-Dioxins and -Dibenzofurans (CDDs and CDFs), Risk Assessment Forum, EPA/625/3-89/016, 8.

17. DALY, H.B. 1990. Reward Reductions Found More Aversive by Rats Fed Environmentally Contaminated Salmon. Neurotoxicology and Teratology; 13: 449-453.

Exhibit L

BEFORE THE
UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION I

In Re:	No. ____________
LINCOLN PULP & PAPER COMPANY NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM Permit No. ME0002003	

DECLARATION OF DR. LAUREN BLUM

1. My name is Lauren Blum. I am a Senior Scientist with the Environmental Defense Fund. I specialize in environmental and economic issues associated with pollution prevention technologies, especially for pulp and paper manufacturing. I developed my expertise in pulp and paper manufacturing during the three and one-half years that I participated on the Paper Task Force, a cooperative project with the large, paper intensive businesses with the goal of increasing their use and purchase of environmentally preferable paper and of creating a model that others could follow. Duke University, Johnson & Johnson, McDonald's, The Prudential and Time Inc. joined EDF as the members of the task force.

2. The task force prepared a final report that included 22 recommendations for purchasing environmentally preferable paper and a technical supplement that included 16 peer-reviewed white papers on the functional performance of specific grades of paper and the economic and environmental issues associated with lifecycle of paper. I coordinated the research on pulp and paper manufacturing for the task force, I conducted extensive research to prepare seven peer-reviewed technical papers on the environmental and economic aspects of pulp, paper, and paperboard manufacturing.

3. My previous experience in the private sector and my background in chemistry and management (I have a Ph.D. in chemistry from MIT and a Master's in Public and Private Management from Yale), served as a strong foundation for my work in this area. Please see the attached C.V. for additional

information on my background.

4. I have analyzed the costs to install a range of elemental chlorine free ("ECF") and total chlorine free ("TCF") bleaching technologies at the Lincoln Pulp and Paper Mill using the economic model developed by the Paper Task Force. As the coordinator of the research on pulp and paper manufacturing for the task force, I spent two years developing this model using information from the literature and from numerous discussions with industry engineers. This model underwent extensive peer review by industry experts as part of the task force research process and reflects their comments.

5. Attached to this declaration are tables of capital costs and operating costs. These tables are similar to those in White Paper No. 7 of the Technical Supplement of the Paper Task Force final report.

6. I have summarized the cost information in Table 1. These total incremental costs demonstrate that there are a number of commercially proven advanced bleaching technologies that provide superior environmental performance to the traditional ECF option that Lincoln is currently considering. The enhanced ECF and ozone ECF options also reduce the discharge of dioxins and are more economical than the option Lincoln has selected. The options that ensure that dioxins are not generated during bleaching, low-effluent TCF processes using a combination of high consistency ozone and hydrogen peroxide, would increase Lincoln's costs by about $8.00 to $12.00 per air-dried metric ton (ADMT) of pulp over the cost to install traditional ECF processes. These

increased costs are insignificant when compared to the cost to produce a metric ton of softwood pulp (about $450) or its current market price ($580). The additional cost associated with installing a low-effluent TCF bleaching process for a ream of 8 1/2 x 11" copy paper ranges from 0.6 to 0.9 cents. The price of a ream of copy paper ranges from $4.00 to $8.00.

7. I have used after-tax costs in order to include the tax savings that results from the depreciation of the capital investment. I have assumed a federal corporate tax rate of 34% and used straight line depreciation over the 15 year life of the equipment. I annualized the capital costs using a 10% cost of capital and a 15 year project life.

8. To calculate the costs for a combination chlorine dioxide and ozone option ("DZ") stage, I assumed that one added 5 kg ozone with the chlorine dioxide and that 1 kg of ozone replaced 1.7 kg of chlorine dioxide. See White Paper No. 7 for additional information about the cost calculations.

Pursuant to 28 U.S.C. Sec. 1746, I, Lauren Blum, hereby declare under penalty of perjury, that the foregoing is true and correct.

Executed on February 27, 1997.

Lauren Blum

Lauren Blum

CURRICULUM VITAE

LAUREN BLUM

Education:

MPPM	Yale School of Managment, 1990
Ph.D.	Massachusetts Institute of Technology, inorganic chemistry, 1985
A.B.	Harvard University, Chemistry, *magna cum laude*

Employment:

1992-Present **Environmental Defense Fund,** New York, New York
Senior Scientist, Paper Task Force, Alliance for Environmental Innovations
Member of SC Johnson/Alliance task force. Serving on a Johnson new product development team to develop strategies to incorporate environmental considerations into the development of new product concepts.
Coordinated research on environmental and economic issues relevant to pulp and paper manufacturing for the Paper Task Force. Prepared seven technical papers on bleached kraft pulp manufacturing, virgin and recycled paper manufacturing and nonwood fibers for papermaking.

1990-1992 **Booz•Allen & Hamilton, Inc.**, New York, New York
Summer 1989 *Associate*, Energy & Chemicals Group
Designed and implemented personnel and training programs for an asbestos litigation support project that employed 250 paralegals. Assessed strategic fit, financial strength and potential integration scenarios using publicly available information for six potential buyers of a consumer products company. Developed discounted cash flow models using client information and industry averages to elucidate requirements to build a worldclass ethical pharmaceutical business for a leading consumer products company. Interviewed client and industry experts extensively to perform a competitive assessment of wire and cable compound producers which included a detailed cost structure of the market leader.

1989 **Yale School of Management**, New Haven, CT
Teaching Assistant, *Data Analysis and Statistics*

1985-1988	**Shipley Company**, Newton, Massachusetts Producer of Specialty Chemicals for the Electronics Industry *Project Leader*, Microelectronic Products Research and Development Presented technical information and worked with customers to optimize process parameters and formulations as a member of a three-person team that successfully introduced a new product to the market. Coordinated a technical team of five to design a new chemical product for use in integrated circuit fabrication processes. Initiated and developed a competitive product evaluation program for standard products. Managed a budget of $50,000 to purchase personal computers, peripherals and software.
1981-1982	**Massachusetts Institute of Technology**, Cambridge, Massachusetts *Teaching Assistant*, Department of Chemistry
Summer 1979	**Ford Motor Company**, Dearborn, Michigan Radcliffe Internship *Technician*, Catalysis Laboratory of Engine and Electrical Engineering Analyzed catalytic converters for their metal content.

Honors:

1983-1984	Sohio Corporation Graduate Fellowship
1980	University nomination for the Rhodes scholarship

Memberships:

American Chemical Society
American Association for the Advancement of Science
Technical Association of the Pulp & Paper Industry
Canadian Pulp & Paper Association

Selected Committees/Activities:

1996	Session Chair, 1996 Environmentally Conscious Design and Manufacturing Conference
1995-1996	15th Reunion Special Gifts Chair, Radcliffe College
1995	Organizing committee for the NSF/DOE workshop on Basic Research Needs for Environmentally Responsive Technologies
1993	Organizing committee for the USDA's Forest Products Laboratory's research conference on sustainable forestry

1989	Producer, "Follies" a first year student review at the Yale School of Management
1987	Committee on the Status and Future of the Radcliffe College Alumnae Association
1986	Treasurer, 5th Reunion at Harvard-Radcliffe

Publications:

Blum, L. 1996. "Maintaining global competitiveness: an environmental group's perspective," *Pulp & Paper*, **70(9)**:72-75 (1996).

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Paper Task Force. 1995. "Environmental Comparison - Manufacturing Technologies for Virgin and Recycled Corrugated Boxes" (White Paper 10B) in *Technical Supplement-Part V* (New York: Environmental Defense Fund, 1995.)

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Paper Task Force. 1996. "Nonwood Plant Fibers as Alternative Fiber Sources for Papermaking (White Paper 13)," in *Technical Supplement - Part IIIA* (New York: Environmental Defense Fund, 1996).

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Bernstein, G., W.-P. Liu, D. K. Ferry, L. Blum. 1988. “High Resolution Electron-Beam Lithography in a Negative Resist,” *J. Vac. Sci Tech. B*.

deGrandpre, M. K. Graziano, S. Thompson, H.-Y. Liu, L. Blum. 1988. "High Resolution, Novolak Based Negative Tone Electron Beam Resist," in *Electron-Beam, X-ray, and Ion Beam Technology: Submicrometer Lithographies VII*, 923 (Bellingham, WA: Society of Photooptical Engineers), 158-163.

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Murray, R.C, L. Blum, A. H. Liu, R. R. Schrock. 1985. "Simple Routes to Mono-η^5-C_5Me_5 Complexes of Molybdenum (V) and Tungsten (V)," *Organometallics*, **4:**953.

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Churchill, M.R., Y.-J. Li, L. Blum, R. R. Schrock. 1984. "Synthesis and Crystallographic Characterization of a Dinuclear 1,2-Hydrazido (2-) Complex of Tungsten (VI): $[W(\eta^5\text{-}C_5Me_4(t\text{-}Bu))(CCMe_3)I]_2(\mu\text{-}N_2H_2).CH_2Cl_2$, *Organometallics*, **3:**109.

Table 1. Annualized after-tax per-ton total costs

Technology option	Capital Costs (Millions of Dollars)	Annualized Capital costs ($/ADMT)	Incremental Operating costs ($/ADMT)	Total cost Year 1 ($/ADMT)
ClO2 upgrade to R8				
Base case	$0.0	$0.0	$0.0	**$0.00**
Traditional ECF	$9.6	$7.40	$17.20	**$24.60**
Traditional ECF + ozone	$12.6	$9.80	$12.60	**$22.40**
Enhanced ECF	$24.1	$18.80	$9.50	**$28.30**
MC Ozone ECF	$24.8	$19.30	$9.40	**$28.70**
HC Ozone ECF	$29.5	$22.90	$8.20	**$31.10**
Enhanced ECF + BFR(TM)	$35.7	$27.70	$12.50	**$40.20**
MC Ozone TCF	$25.9	$20.20	$27.10	**$47.30**
HC Ozone TCF	$30.7	$23.80	$12.60	**$36.40**
New ClO_2 generator				
Base case	$0.0	$0.00	$0.0	**$0.00**
Traditional ECF	$13.5	$10.50	$17.80	**$28.30**
Traditional ECF + ozone	$14.5	$11.20	$12.90	**$24.10**
Enhanced ECF	$24.9	$19.40	$9.50	**$28.90**
MC Ozone ECF	$24.8	$19.30	$9.40	**$28.70**
HC Ozone ECF	$29.5	$22.90	$8.20	**$31.10**
Enhanced ECF + BFR	$36.4	$28.30	$12.50	**$40.80**
MC Ozone TCF	$25.9	$20.20	$27.10	**$47.30**
HC Ozone TCF	$30.7	$23.80	$12.60	**$36.40**
Tax rate		34%		

APPENDIX: Cost Calculation for Lincoln Pulp & Paper

I used the following assumptions about the current manufacturing process based on my earlier work and our discussions.

- **Capacity:** 500 air-dried tons per day (453 air-dried metric tons)
- **Kappa number:** 25 (results from a mix of softwood and sawdust)
- **Chlorine dioxide substitution:** 30%
- **Active chlorine factor:** 0.16 (% active chlorine/kappa number). This kappa factor is used by many mills with this level of substitution.

Using this information, I then determined the amount of additional chlorine dioxide capacity Lincoln would need for three ECF sequences:

- **100% chlorine dioxide subsitution (D(EOP)DD)** – Traditional ECF in the Paper Task Force report

- **100% chlorine dioxide substitution with ozone ((DZ)(EOP)DD)** – Traditional ECF + ozone

- **Oxygen delignification + 100% chlorine dioxide substitution (OD(EOP)DD)** – Enhanced ECF

Since the largest increase in chlorine dioxide capacity was less than 11 tons per day, I evaluated 2 scenarios.

- **Lincoln meets its needs by upgrading its existing chlorine dioxide generator to an R8 or SVP-lite generator.** These newer processes generate very small quantities of elemental chlorine during ClO_2 production.

- **Lincoln installs new generators.** The mill already converted to R8 generation to achieve 30% substitution.

Table A-1 presents the costs of these upgrades for the three ECF sequences.

Table A-1. Capital costs for chlorine dioxide system upgrades

	R8 upgrade	New capacity
Traditional ECF (D(EOP)DD)		
Additional chlorine dioxide required (metric tons per day)	9.0	9.0
Chlorine dioxide capacity upgrade		
Improved mixing and control	$0.9	$0.9
Increased storage and other equipment for ClO2	$1.7	$1.7
Additional ClO2 capacity	$2.2	$6.2
TOTAL	**$4.8**	**$8.7**
Traditional ECF with ozone((DZ)(EOP)DD)		
Additional chlorine dioxide required (metric tons per day)	5.0	5.0
Chlorine dioxide capacity upgrade		
Improved mixing and control	$0.9	$0.9
Increased storage and other equipment for ClO2	$1.0	$1.0
Additional ClO2 capacity	$2.0	$3.9
TOTAL	**$3.8**	**$5.7**
Enhanced ECF (OD(EOP)DD)		
Additional chlorine dioxide required (metric tons per day)	3.0	3.0
Chlorine dioxide capacity upgrade		
Improved mixing and control	$0.9	$0.9
Increased storage and other equipment for ClO2	$0.6	$0.6
Additional ClO2 capacity	$1.8	$2.6
TOTAL	**$3.3**	**$4.0**

Table A-2 contains the capital cost estimates for individual pieces of equipment and **Table A-3** presents the capital costs to install advanced ECF and TCF bleaching technologies at the Lincoln mill. I have assumed that the mills close the screen room and upgrade brownstock washing to reduce chemical costs and to improve effluent quality. Tables A-4 presents detailed chemical consumption data for each stage of the bleaching processes. **Table A-5** presents the total chemical consumption data and estimates of chemical, power and maintenance costs used to calculate the incremental operating costs.

Table A-2. Capacity and cost indices for major capital expenses

Installed costs for equipment (Millions of 1994 dollars)

Equipment	Source	Installed cost (C_0) (millions of dollars)	Capacity (Cap_0) (ADMT/D)	Cost index (n)
Closed screen room	1	$1.4	750	0.4
Brownstock washing upgrade	1	$4.5	850	0.65
New brownstock washing line	1	$15.3	550	0.4
Monitor Bleach plant filtrates	1	$0.1	700	0.05
Oxygen delignification	1	$17.5	720	0.35
New continuous digester	1	$53.0	1000	0.5
Ozone bleaching system (medium consistency)	1	$4.2	500	0.25
Ozone bleaching system (high consistency)	2	$15.0	1000	0.6
Recausticizing upgrade	1	$3.1	1000	0.8
Peroxide tower	3	$2.0	1000	0.6
BFR™ technology	4	$20	1000	0.6
Chlorine dioxide system upgrade				
Improved ClO2 mixing and control	1	$1.0	550	0.6
Increased storage and other equipment for ClO2	1	$1.1	24 tpd ClO_2	0.9
New chlorine dioxide generator only	1	$15.6	30 tpd ClO_2	0.8
Conversion of R3/SVP ClO2 generator	1	$2.0	10 tpd ClO_2	0.2
Recovery boiler upgrade	1	$6.0	2900 GJ/day	0.65

Note to calculate the capital costs:

Cap = capacity of equipment
Cap_0 = baseline capacity of equipment
C = capital cost of equipment
C_0 = baseline capital cost of equipment
n = cost index

$$C = C_0 \times \left(\frac{Cap}{Cap_0} \right)^n$$

Sources: [1] U.S. EPA, BAT Cost Model Support Document, Pulp & Paper Cluster Rule DCN 13953 Record Section 23.1.2, July 9, 1996.

[2] Bruce Griggs, High Consistency Ozone Delignification, letter to Lauren Blum, May 31, 1994.

[3] G. Homer and T. Govers, "Ozone-based ECF and TCF Bleaching: Mill Experience, Laboratory Data and Cost Considerations," *TAPPI Proceedings of the 1994 Pulping Conference* (Atlanta: TAPPI Press, November 1994), 1056.

[4] G. Maples et al., "BFR: A New Process Toward Bleach Plant Closure," *Papers presented at the 1994 International Pulp Bleaching Conference*, Vancouver, BC, June 13-16, 1994, 253 - 262.

Table A-3. Capital costs for the technology options

	ClO2 upgrade	New generator
Traditional ECF		
Close screen room	$1.1	$1.1
Upgrade brownstock washing	$2.8	$2.8
Chlorine dioxide system upgrade	$4.8	$8.7
Recovery boiler capacity upgrade	$1.0	$1.0
Total	**$9.6**	**$13.5**
Traditional ECF + Ozone (DZ)		
Closed screen room	$1.1	$1.1
Upgrade brownstock washing	$2.8	$2.8
Chlorine dioxide system upgrade	$3.8	$5.7
MC ozone mixer + tower	$3.9	$3.9
Recovery boiler capacity upgrade	$1.0	$1.0
Total	**$12.6**	**$14.5**
Enhanced ECF		
Closed screen room	$1.1	$1.1
Upgrade brownstock washing	$2.8	$2.8
Chlorine dioxide system upgrade	$3.3	$4.0
Oxygen Delignification	$14.2	$14.2
Recausticizing upgrade	$1.5	$1.5
Recovery boiler capacity upgrade	$1.3	$1.3
Total	**$24.1**	**$24.9**
Ozone (MC) ECF		
Close screen room	$1.1	$1.1
Upgrade brownstock washing	$2.8	$2.8
Oxygen Delignification	$14.2	$14.2
MC Ozone tower	$3.9	$3.9
Recausticizing upgrade	$1.5	$1.5
Recovery boiler capacity upgrade	$1.3	$1.3
Total	**$24.8**	**$24.8**
Ozone (HC) ECF		
Close screen room	$1.1	$1.1
Upgrade brownstock washing	$2.8	$2.8
Oxygen Delignification	$14.2	$14.2
HC Ozone tower	$8.7	$8.7
Recausticizing upgrade	$1.5	$1.5
Recovery boiler capacity upgrade	$1.3	$1.3
Total	**$29.5**	**$29.5**
MC Ozone/peroxide TCF		
Close screen room	$1.1	$1.1
Upgrade brownstock washing	$2.8	$2.8
Oxygen Delignification	$14.2	$14.2
MC Ozone tower	$3.9	$3.9
Peroxide tower	$1.2	$1.2
Recausticizing upgrade	$1.5	$1.5
Recovery boiler capacity upgrade	$1.3	$1.3
Total	**$25.9**	**$25.9**
HC Ozone peroxide TCF		
Close screen room	$1.1	$1.1
Upgrade brownstock washing	$2.8	$2.8
Oxygen Delignification	$14.2	$14.2
HC Ozone tower	$8.7	$8.7
Peroxide tower	$1.2	$1.2
Recausticizing upgrade	$1.5	$1.5
Recovery boiler capacity upgrade	$1.3	$1.3
Total	**$30.7**	**$30.7**

Table A-4. Estimate of chemical charges to produce softwood bleached kraft pulp

Operating cost estimates

Softwood	(C70D30)(EOP)DD	D(EOP)DD	(DZ)(EOP)DD	OD(EOP)DD	OZmc(EOP)DD	OZhc(EOP)DD	OQQPZmcP	OZhcQPZP
Kappa out of digester	25	25	25	25	25	25	25	25
Oxygen delignification efficiency	100%	100%	100%	50%	50%	50%	50%	50%
Kappa out of OD	25	25	25	12.5	12.5	12.5	12.5	12.5
Sodium sulfate washing loss (kg/ADMT pul	13.5	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Percentage of Kappa value	17.5%	6.5%	6.5%	6.5%	6.5%	6.5%	6.5%	6.5%
Kappa equivalents	4.4	1.6	1.6	0.8	0.8	0.8	0.8	0.8
Kappa number into bleach plant	29.4	26.6	26.6	13.3	13.3	13.3	13.3	13.3
Anthraquinone to digester					0.0	0.0	0.0	0.0
Oxygen delignification								
Oxygen (kg/ADMT)				20.0	20.0	27.0	12.5	27.0
Magnesium sulfate (kg/ADMT)				3.6	3.6	4.9	2.3	4.9
Oxidized white liquor (kg/ADMT)				20.0	20.0	27.0	12.5	27.0
C/D stage								
pulp entering bleaching stage (ADMT)	1.08	1.08	1.08	1.04				
Kappa factor	0.16	0.22		0.22				
Chlorine dioxide substitution level	30%	100%		100%				
Chlorine (kg/ADMT)	15.2	0		0				
Chlorine dioxide - first stage (kg/ADMT)	5.8	24.0	15.5	11.6				
Sulfuric acid (kg/ADMT)	0.0	14.4	9.3	6.9				
Shrinkage	4%	4%	4%	3%				
Ozone stage								
pulp entering bleaching stage (ADMT)			5.0		1.035	1.035	1.035	1.035
Ozone (kg/ADMT)					5.4	7.9	3.9	8.5
Chelant (kg/ADMT)					1.1	1.1		1.1
Sulfuric Acid (kg/ADMT)					27	27		31.5
Sodium hydroxide (kg/ADMT)					5.4	5.4		5.4
Sodium hydroxide (recovered) (kg/ADMT)					-5	-6.5		-7.9
Shrinkage					0.02	0.02	0.02	0.02
Extraction stage (EOP)								
pulp entering bleaching stage (ADMT)	1.04	1.04	1.04	1.01	1.01	1.01	1.01	
Caustic (kg/ADMT)	25.9	32.2	32.2	16.1	5.4	5.4	42.0	
Oxygen (kg/ADMT)	5.2	5.2	5.2	5.1	5.1	5.4	0.0	
Hydrogen peroxide (kg/ADMT)	3.0	3.1	3.1	3.0	3.0	3.7	0.0	
Shrinkage	3%	3%	3%	1%	1%	1%	1%	
Final Chlorine dioxide stages (DD) (kg/ADMT)								
Chlorine dioxide (kg/ADMT)	14.0	14.0	14.0	14.0	16.4	12.1		
Sodium Hydroxide (kg/ADMT)	8.4	8.4	8.4	8.4	9.8	7.3		
Chelant Stage								
Chelant (kg/ADMT)							2.6	2.2
Sulfuric acid							8.3	8.3
Peroxide stages								
Hydrogen peroxide (kg/ADMT)							35	15.4
Sodium Hydroxide (kg/ADMT)								10.8
Magnesium sulfate (kg/ADMT)								2.3

Table A-4. Estimate of chemical charges to produce softwood bleached kraft pulp (cont'd)

Notes:
[1] Source: Robert Okell, Weyerhaeuser Paper Company, personal communication, September 12, 1994. The percentage of kappa value is proportional to the carry-over from brownstock washing.

[2] Effective increase in kappa number that results from the carry-over of dissolved organic material with the pulp.

[3] Kappa factor = % active chlorine / brownstock kappa number,
% active chlorine = $\%Cl_2 + 0.263 \times \%ClO_2$.

[4] MC ozone charge from Vice et al., 1995 *International Non-Chlorine Bleaching Conference*; HC ozone charge from Wells Nutt, letter to Lauren Blum, October 24, 1994.

[5] We used a caustic charge of 55% of the active chlorine in the first bleaching stage [Source: Thomas Wiesmann, International Paper, personal communication, May 25, 1994.]

[6] Typical industry usage for reinforced alkali extraction.

[7] Typical chlorine dioxide charges in the final bleaching stages range from about 8 kg to 15 kg/ADMT pulp depending on the wood species and brightness target. We chose a chlorine dioxide charge of 14 kg/ADMT for the softwood conventional ECF and enhanced ECF processes based on information from Jean Renard at International Paper [letter to Lauren Blum, October 1994].

[8] The final chlorine dioxide charges for the ozone ECF processes were calculated by subtracting 2 times the ozone charge from the total chlorine dioxide charge used in the enhanced ECF process. [Source: Vice, et al., *1995 International Non-Chlorine Bleaching Conference*]

Table A-5. Estimate of operating costs to produce softwood bleached kraft pulp (cont'd)

	(C70D30)(EOP)DD	D(EOP)DD	(DZ)(EOP)DD	OD(EOP)DD	OZmc(EOP)DD	OZhc(EOP)DD	OQQPZmcP	OZhcQPZP	Cost
Chemical Charges (kg/ADMT bleached pulp)									
Chlorine	15.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	$0.20
Chlorine dioxide	19.8	38.0	29.5	25.6	16.4	12.1	0.0	0.0	$1.02
Sulfuric Acid	0.0	14.4	9.3	6.9	27.0	27.0	8.3	39.8	$0.07
Sodium hydroxide	0.0	40.6	40.6	24.5	15.6	11.6	42.0	8.3	$0.40
Sodium hydroxide (without Cl2)	34.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	$0.23
Oxygen	5.2	5.2	5.2	25.1	25.1	32.4	12.5	27.0	$0.06
Oxidized white liquor	0.0	0.0	0.0	20.0	20.0	27.0	12.5	27.0	$0.05
Magnesium sulfate	0.0	0.0	0.0	3.6	3.6	4.9	2.3	7.2	$0.50
Ozone (MC)	0.0	0.0	0.0	0.0	5.4	0.0	3.9	2.1	$1.60
Ozone (HC)	0.0	0.0	0.0	0.0	0.0	7.9	0.0	6.4	$1.40
Hydrogen peroxide	3.0	3.1	3.1	3.0	3.0	3.7	35.0	15.4	$1.15
Chelating agent	0.0	0.0	0.0	0.0	1.1	1.1	2.6	3.3	$1.00
Anthraquinone	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	$4.00
Power for oxygen and ozone mixing (kWh/ADMT)			35	35	70	70	70	70	$0.04
ClO2 upgrade to R8 system									
Chemical costs	$34.87	$59.96	$50.93	$44.18	$42.42	$41.06	$68.97	$45.99	
Power costs	$0.00	$0.00	$1.40	$1.40	$2.80	$2.80	$2.80	$2.80	
Maintenance	$0.00	$1.02	$1.66	$3.75	$3.90	$3.44	$4.14	$5.15	
TOTAL OPERATING COSTS	$34.87	$60.98	$53.99	$49.34	$49.11	$47.29	$75.91	$53.95	
Change from base case	$0.00	$26.11	$19.12	$14.47	$14.24	$12.42	$41.04	$19.08	
New ClO2 Generator									
Chemical costs	$34.87	$59.96	$50.93	$44.18	$42.42	$41.06	$68.97	$45.99	
Power costs	$0.00	$0.00	$1.40	$1.40	$2.80	$2.80	$2.80	$2.80	
Maintenance	$0.00	$1.87	$2.07	$3.92	$3.90	$3.44	$4.14	$5.15	
TOTAL OPERATING COSTS	$34.87	$61.82	$54.40	$49.50	$49.11	$47.29	$75.91	$53.95	
Change from base case	$0.00	$26.95	$19.53	$14.63	$14.24	$12.42	$41.04	$19.08	

Table A-5. Estimate of operating costs to produce softwood bleached kraft pulp (cont'd)

Notes: [1] Source: G. Homer and T. Govers, "Ozone-based ECF and TCF Bleaching: Mill Experience, Laboratory Data and Cost Considerations," *TAPPI Proceedings of the 1994 Pulping Conference* (Atlanta: TAPPI Press, November 1994), 1061. Chlorine dioxide cost has been adjusted to account for chemical cost and maintenance cost only. We used the chemical costs for sodium chlorate, methanol and sulfuric acid presented on page 1055, but used 1.74 kg of sodium chlorate based on a 95% yield of chlorine dioxide from sodium chlorate.

[2] Source: Jean Renard, personal communication, May 26, 1995.

[3] We have calculated the maintenance costs as 3% of the capital costs of new equipment installed at the mill. The total cost has been adjusted to a per ton cost by assuming that the mills run at full capacity 350 days per year. We have included maintenance costs for oxygen delignificaton, ozone and hydrogen peroxide bleaching. We do not include the new chlorine dioxide generator, because we have assumed that mill personnel already have experience with an R-8 chlorine dioxide generator.